CONFIDENTIAL

AD 342843L

DEFENSE DOCUMENTATION CENTER

FOR

SCIENTIFIC AND TECHNICAL INFORMATION

CAMERON STATION, ALEXANDRIA, VIRGINIA

CONFIDENTIAL

NOTICE: When government or other drawings, specifications or other data are used for any purpose other than in connection with a definitely related government procurement operation, the U. S. Government thereby incurs no responsibility, nor any obligation whatsoever; and the fact that the Government may have formulated, furnished, or in any way supplied the said drawings, specifications, or other data is not to be regarded by implication or otherwise as in any manner licensing the holder or any other person or corporation, or conveying any rights or permission to manufacture, use or sell any patented invention that may in any way be related thereto.

NOTICE:

THIS DOCUMENT CONTAINS INFORMATION AFFECTING THE NATIONAL DEFENSE OF THE UNITED STATES WITHIN THE MEANING OF THE ESPIONAGE LAWS, TITLE 18, U.S.C., SECTIONS 793 and 794. THE TRANSMISSION OR THE REVELATION OF ITS CONTENTS IN ANY MANNER TO AN UNAUTHORIZED PERSON IS PROHIBITED BY LAW.

(4) NA (5) 627400

(1)

CONFIDENTIAL

NRL Report 495
Copy No. 1

NRL 4950

342843

PROJECT VANGUARD REPORT NO. 16
PROGRESS THROUGH APRIL 15, 1957

[UNCLASSIFIED TITLE]

Project Vanguard Staff

May 1, 1957

Further distribution of this report, or of an abstract or reproduction, may be made only with the approval of the Director, U.S. Naval Research Laboratory, Washington 25, D. C.

NOT RELEASABLE TO FOREIGN NATIONALS

NAVAL RESEARCH LABORATORY
Washington, D.C.

See cat 34279

CONFIDENTIAL

SECURITY

This document contains information affecting the national defense of the United States within the meaning of the Espionage Laws, Title 18, U.S.C., Sections 793 and 794. The transmission or the revelation of its contents in any manner to an unauthorized person is prohibited by law.

PREVIOUS PROJECT VANGUARD REPORTS

Project Vanguard Report No. 1, "Plans, Procedures, and Progress" by the Project Vanguard Staff, NRL Report 4700 (Secret), January 13, 1956

Project Vanguard Report No. 2, "Report of Progress" by the Project Vanguard Staff, NRL Report 4717 (Confidential), March 7, 1956

Project Vanguard Report No. 3, "Progress through March 15, 1956" by the Project Vanguard Staff, NRL Report 4728 (Confidential), March 29, 1956

Project Vanguard Report No. 4, "Progress through April 15, 1956" by the Project Vanguard Staff, NRL Report 4748 (Confidential), May 3, 1956

Project Vanguard Report No. 5, "Progress through May 15, 1956" by the Project Vanguard Staff, NRL Report 4767 (Confidential), June 2, 1956

Project Vanguard Report No. 6, "Progress through June 15, 1956" by the Project Vanguard Staff, NRL Report 4800 (Confidential), June 28, 1956

Project Vanguard Report No. 7, "Progress through July 15, 1956" by the Project Vanguard Staff, NRL Report 4815 (Confidential), July 27, 1956

Project Vanguard Report No. 8, "Progress through August 15, 1956" by the Project Vanguard Staff, NRL Report 4832 (Confidential), September 5, 1956

Project Vanguard Report No. 9, "Progress through September 15, 1956" by the Project Vanguard Staff, NRL Report 4850 (Confidential), October 4, 1956

Project Vanguard Report No. 10, "Progress through October 15, 1956" by the Project Vanguard Staff, NRL Report 4860 (Confidential), November 4, 1956

Project Vanguard Report No. 11, "Progress through November 15, 1956" by the Project Vanguard Staff, NRL Report 4880 (Confidential), December 3, 1956

Project Vanguard Report No. 12, "Progress through December 15, 1956" by the Project Vanguard Staff, NRL Report 4890 (Confidential), January 16, 1957

Project Vanguard Report No. 13, "Progress through January 15, 1957" by the Project Vanguard Staff, NRL Report 4900 (Confidential), February 7, 1957

Project Vanguard Report No. 14, "Progress through February 15, 1957" by the Project Vanguard Staff, NRL Report 4910 (Confidential), March 12, 1957

Project Vanguard Report No. 15, "Progress through March 15, 1957" by the Project Vanguard Staff, NRL Report 4930 (Confidential), April 2, 1957

CONTENTS

PREFACE

This report is intended as a general summary of the progress on Project Vanguard during the indicated period. Hence, minor phases of the work are not discussed to a great extent, and technical detail is kept at a minimum. It is hoped that the information here presented will be of assistance to administrative and liaison personnel in coordinating and planning their activities, and as a guide to the current status of the project. Material of a more technical nature will be published from time to time in separate reports which will be announced in subsequent monthly progress reports.

PROBLEM STATUS

This is an interim report; work on the problem is continuing.

AUTHORIZATION

NRL Problem A02-90

Manuscript submitted April 25, 1957

THE LAUNCHING VEHICLE

CONFIGURATION AND DESIGN

Computations are being made of the probability that random wind gust loads will produce excessive bending moments in the launching vehicle structure. The initial results indicate a probability of 0.15 that a moment exceeding 300,000 inch-pounds will be caused at the first-stage intertank structure by gust loading at some time during flight through the atmosphere. Since the calculation routine is quite lengthy, it is necessary to check rather carefully before this result can be depended upon; steps are being taken to initiate an independent determination of this figure. This study was based upon statistical data on a wide variety of conditions which might produce wind gusts in excess of those stated in the specification.*

To further investigate the structural bending attributed to controls noise,* closed-loop tests have been conducted on the vertical TV-2 vehicle. REAC simulation was used to represent the aero rigid body and the first- and second-mode elastic bending. Conditions at launch, maximum dynamic pressure, and burnout were examined. Under these conditions, the ratios of allowable to measured bending at the gyro location were 10, 15, and 10, respectively, for the first mode and 5, 8, and 3 respectively, for the second mode. From these tests, which were more elaborate than the earlier tests, it is concluded that the bending attributed to controls noise will be lower than was expected. During these tests a low-frequency "hunting" was observed with an amplitude of 0.03 degree and a frequency of 1 cps at burnout. This is attributed to the nonlinearity of the gain-versus-error curve of the transfer valve for small errors.

Nyquist plots have been made of the frequency response in the REAC study of structural feedback.* These plots disclose discrepancies in amplitude and phase when compared to theoretical results obtained from the structural transfer function. To check these data, portions of the REAC study will be rerun. During the runs the cross-coupling terms will be successively removed in order to provide a closer correlation between the structural and aerodynamic transfer functions.

The temperature limitations of the satellite when installed in the vehicle second stage have been established. It is required that under no condition of ground test and preflight countdown shall the outer shell temperature of the satellite exceed 30°C. The Glenn L. Martin Co. is determining the best method for cooling the satellite.

Preliminary examination of the problem indicates that a cooling air system similar to that used to cool the controls components will be necessary. This would require the addition of an air hose and a disconnect to the upper portion of the second stage. To avoid damage to the delicate surface coatings on the satellite, the air supply would be dried and filtered.

Environmental testing of launching vehicle electrical components and assemblies is continuing as equipment and facilities become available. Vibration equipment suitable for assemblies up to 25 lb have been received. The rotary inverters to be used for the 400-cps 120-volt power supply in the Vanguard vehicles are presently being vibration tested in the range of 0-500 cps. The functional mockup of the Vanguard electrical system is nearing

---

* P.V.R. No. 15, p. 1

completion, and connecting cables are being prepared. This mockup will provide a means of checking out the complete vehicle electrical system. It is also planned to operate the controls system in conjunction with the electrical system mockup; critical operations, such as stage separation, will be simulated and the effect on the controls and electrical systems observed.

The modification of the aft end of the launching vehicle to relocate disconnects and the revision of the configuration of the launch stand pads are now underway.*

PROPULSION

First Stage

Attempts to complete acceptance test firing of a production first-stage motor† have not yet been successful, owing to (1) a cracked weld in the thrust chamber wall which could not be rewelded, and (2) an inner liner score.

Evidence indicates that the prime cause of previous failures and inconsistencies in the first-stage motor tests has been inadequate quality control of chambers and, particularly, of injectors. GE has now expanded its quality control efforts on all hardware, with special emphasis on injector fabrication.

Approximately 25 more firings have been made to evaluate injector modifications in continuation of the program to eliminate the problem of first-stage chamber burnouts. Most of the testing has been directed toward determining the capability of a "precision drilled" injector and a final configuration chamber to last through a cumulative total of 2000 seconds of firing. This life testing required that the motor remain intact for 14 consecutive full-duration firings with little or no scoring of the motor body. Such a test was required in order to gain sufficient assurance of motor reliability. The first delivered "precision drilled" injector fulfilled these requirements, and the assembly of a production engine with the second "precision" injector and final configuration chamber is underway. Testing of this engine is anticipated in the latter part of April.

Second Stage

The Aerojet-General Corp. has continued prequalification tests with several attempts to fire: one short check firing, one 35-second firing, and one 60-second firing. The 35-second run was terminated because a snap ring failed at the helium tank outlet, causing a loss of pressure. Corrective action was taken and another long run was attempted but was manually shut down after about 60 seconds because of low chamber pressure and high flow rate caused by an oxidizer drain plug having blown off at the end of the expansion nozzle. Another thrust chamber is being installed and prequalification firings will continue about 16 April.

The prequalification unit which was damaged by fire resulting from a fuel line rupture‡ has been replaced with another unit originally intended for delivery as Propulsion Unit No. 1. The next unit, complete with tank assembly, has been designated Propulsion Unit No. 1 and is being installed in a test stand for acceptance tests.

---

*P.V.R. No. 15, p. 7

†P.V.R. No. 15, p. 3

‡P.V.R. No. 15, p. 4

Further tests and evaluation of the Futurecraft regulator[†] have determined that it is unsuitable for use in the Aerojet second-stage helium pressurization system. However, the Futurecraft Co. has redesigned the regulator to a three-stage pressure-dome loaded type which apparently would be satisfactory. The modified regulator is being evaluated.

There are now nine tank assemblies completed and ready to be assembled into propulsion units. The tank assembly which was being subjected to cycle tests at the end of the previous report period apparently withstood the tests successfully; the tanks burst at 540 psi. However, analysis of the data has not yet been completed.

The status of the principal second-stage propulsion components is as follows:

1. Three tank assemblies are completed, tested, and assembled.

2. Seven tanks are completed and proof tested (includes the three listed above).

3. Fifteen thrust chambers have been completed. Eleven are required by the contract for delivery; thus the thrust chamber quota has been filled.

4. Ten injectors have been completed and test fired. All ten give the characteristic exhaust velocity (C*) above 4980 fps which is required by the specifications, the highest C* being about 5100 fps.

Third Stage

Grand Central Rocket Company

The Grand Central Rocket Company (GCR) has begun work on a program to bring the performance of their third-stage rocket up to specifications. The method of improvement consists of reduction of the weight of inert parts. By reducing the thickness of inert liner between the thick propellant web sections and reducing the amount of graphite in the nozzle insert, a significant gain in mass ratio can be made. Ten test firings were planned, the last five employing the final configuration.

Two techniques for reducing the liner thickness have been tried. One utilized 91LD phenolic resin as the greater mass with a small amount of LP-3 rubber added, and the second utilized LP-3 as the greater mass with a small portion of 91LD added. Two firings were conducted with the liner weight reduced from 5.5 lb to 3.5 lb. Both of these firings yielded satisfactory results, but slightly lower external case temperatures were indicated with the first of the above compositions. Both of these firings also employed a hollowed-out graphite nozzle insert with 91LD as an insulator between the graphite and the cylindrical section of the nozzle. The graphite insert weight was thus reduced by about 2 lb. A third firing ended in a burn-through after about 75 percent of full duration. Examination indicated a breakdown of the 91LD bond, which admitted combustion gasses under the hollowed graphite nozzle insert, burning the case. To overcome this difficulty, the strength of the 91LD entrance seal has been increased. Further tests are planned.

Efforts to reduce the ignition delay are also being made. The propellant content in the igniter has been increased to propagate a greater flame, and the nozzle closure has been modified by varying the size of the burst orifice with cast Stafoam to give more

[†]P.V.R. No. 15, p. 5

reproducible burst times. The initial tests indicate a slight reduction in ignition delay, but the burst closure diameter has not been finalized.

The present GCR schedule calls for the five remaining prototype rockets to be fired between 25 and 30 April. With the present specific impulse of 239 sec at altitude and a total weight of 433 lb loaded and 49.6 lb empty, the specification incremental velocity of 14,182 fps with a payload of 22.1 lb can be realized.

Allegany Ballistics Laboratory

The Allegany Ballistics Laboratory (ABL) has continued its third-stage rocket improvement program employing a fiberglass case with a phenolic asbestos insulating liner, a phenolic asbestos insulating sleeve at the slotted section of the propellant, and case bonding of the propellant charge into the chamber.* Three chambers thus fabricated have been hydrostatically tested, but all failed at a pressure of 320 psi. Analysis revealed that the phenolic asbestos liner was cured with the fiberglass case and water vapor from the phenolic asbestos weakened the fiberglass. Measures intended to assure adequate curing of the 5-mil asbestos liner before winding of the fiberglass case have been taken, and testing will continue.

Tests have also been conducted (on fiberglass cases without the 5-mil asbestos liner) of means of bonding both silica rubber and phenolic asbestos insulators to the aft portion of the case. The purpose of these tests was to verify the case bonding method and to determine the adequacy of the bonding material used on the insulators, so that the necessary modifications in the method of fabrication might be made before prototype testing began. Hydrostatic tests of these cases were successful. One firing employing this type of case terminated after 21 seconds of firing when sudden high-pressure peak caused a failure of the closure section. Analysis showed that insufficient propellant curing time might be the cause of this problem. The curing time has been extended and further tests are planned.

Testing of the molded resonance suppressor in two cartridge type configurations has demonstrated the adequacy of the suppressor. Vacuum ignition was also checked during one of these tests in a modified booster case; ignition was normal at a pressure of 10 mm of mercury.

ABL is now scheduled to make the first two firings of the new configuration in the latter part of April.

FLIGHT CONTROL

Guidance

The first Minneapolis-Honeywell flight reference system has passed acceptance tests. In addition, an "engineering" unit has been received for environmental testing. Delivery of one additional unit on the 15th of each month is now scheduled. Qualification of the reference system is expected prior to the vertical controls tests of TV-3.

---

*P.V.R. No. 15, p.6

Attitude Control

The acceptance tests on the magnetic amplifier autopilot are being conducted at the Vickers plant, since the acceptance test equipment has not yet been delivered to GLM.

Tests of the first-stage roll jet mockup and of the roll jet nozzles installed in TV-2 have revealed the necessity for some mechanical modification of the pneumatic actuators. The assembly mounting is being stiffened and an outboard support bearing has been added. Present mockup tests are being conducted with the reworked actuator. Lost motion in the actuator linkage has been reduced and acceptable performance should be obtained. Nozzle seal leakage during hot jet tests has caused degradation of the control response and eventual failure; the faulty seals were found to have been incorrectly machined.

Mockup tests on the second-stage pitch-yaw jet system have been completed with an electronic autopilot; the system performed satisfactorily with the expected fuel consumption.

Tests on the second-stage dynamic mockup indicate the reduction in the natural frequency of the engine attributed to compression of the hydraulic fluid was greater than was expected. The natural frequency requirement of the second-stage engine has been reset as 30 cps as a result of these tests.

Flight Program and Staging

The acceptance tests of the first programmer have been completed. However, the qualification tests have not been made. This unit will be returned to Designers for Industry, Inc., for replacement of the present steel sprocket with an aluminum one. Meanwhile, eight additional units have been authorized for shipment prior to qualification. Qualification testing is to start 15 April, with completion expected by 20 June. The delivered units will be installed in the vehicles as flight items and will be subjected to system tests. Qualification will be effective by the time of the vertical controls acceptance tests on TV-3 at the GLM plant.

One coasting time computer has been received and accepted, and a second unit is undergoing qualification tests. Acceptance tests include a checkout of the integrating accelerometer in a 1-g field, while qualification requires a 10-g field. Some difficulty is being experienced in meeting the desired accuracy under these conditions.

A computer study will be made to determine the magnitude of vehicle attitude deviation which would obtain for a delayed first-stage separation in which no additional attitude stabilization systems are employed. This study will also determine the required magnitude of first-stage retro thrust and second-stage boost thrust. It is expected that a first-stage back-up system entailing minimum modification of the vehicle can be engineered if this study indicates the feasibility of delayed separation.* Further work is in progress on the present first-stage separation scheme, taking into account the curve of second-stage thrust reactive force on the first stage established from the data obtained in the Aerojet impingement tests.† A test program is being conducted to evaluate alternative lox dome insulation materials to replace the blanket design which failed during the impingement tests.

*P.V.R. No. 6, pp. 9-10

†P.V.R. No. 14, p. 6

Another test has been made on the third-stage spinup and separation mockup. Functional operation was satisfactory. Circuit sequences, ignition of spin and retro rockets, and disengagement of the turntable clamps and forward spider arms functioned properly. Retraction of the second-stage structure was smooth. During this test a wobble was imparted to the spinning third stage by a ground wind, and interference occurred between the extreme tip of the third-stage nozzle and the lip of the second-stage opening. However, since there will be no winds at orbital altitude, the test is considered successful. No further spinup tests are scheduled prior to the flight of TV-1.

At present, it is proposed to initiate third-stage spin and separation on TV-3 by means of a 476-second cam on the programmer; operation of the coasting time computer and the 180-second timer (which is energized by ground command) would be flight tested but would not initiate third-stage spin and separation. A proposal has been made to change the circuitry so that a backup signal for the programmer could be given by ground command; this would involve changing the time setting of the 180-second timer. A further study, made to determine the effect of this undertaking on the TV-3 schedule, indicates that the changes required to make the present 180-second timer serve as a backup for initiation of spin and separation are feasible. Action has been initiated to effect the required changes.

THE SATELLITE

CONFIGURATION AND DESIGN

Installation of the wide-band random noise test equipment at NRL was completed on 5 April 1957. This equipment provides a random vibration test over a frequency range from 10 to 2000 cps with a flat (white) spectral energy distribution and is capable of meeting the current final design vibration test specified for the VANGUARD Satellite. Certain components of the above system not essential for the specified random vibration test have not been delivered. It is estimated that most of these undelivered items will be delivered on or before 15 May 1957.

Failure of a component of the vibration shaker has caused a delay in the vibration test schedule. However, the equipment is expected to be in operation again shortly.

All satellite separation mechanisms have now been delivered; and inspection and testing is proceeding.

20-Inch Satellites

Magnesium 20-inch satellites 12, 13, 14, and 15 have been received and are being inspected, weighed, and pressure tested. This completes the present order for 20-inch satellites.

Magnesium unit no. 3 has undergone horizontal and vertical vibration tests with an internal package weight of 10 pounds, 6 ounces. This unit had been modified to accommodate another ion chamber.* Four new-type microphones were mounted in the satellite. A stainless-steel sleeve and pin were used to simulate a separation mechanism by allowing the pin to remain loose. Vibration transmissibility data were recorded during the test, and a comparison of these data with those for magnesium unit no. 4, which was vibrated with a separation mechanism, was made. (Both units had a reinforcing doubler added to the base of the internal package.) No failures were observed, although the microphone screws were loosened slightly.

6.44-Inch Satellites

Magnesium 6.44-inch satellites 9, 10, 11, and 12 have been received. Units 5 and 6 have been given the final silicon monoxide coating and are now ready for environmental tests. Units 9 and 10 are being modified for use as mockups of a new six-antenna satellite design.

A revised minimum satellite package is now being designed to provide a second Minitrack transmitter which, in combination with the normal Minitrack transmitter, will permit determination of the temperature at a point on the outer shell of the satellite as well as within the internal package. This satellite, to be approximately six inches in diameter,

---

*P.V.R. No. 15, p. 8

will probably be used in TV-4 and TV-5, and will also provide a minimum-sized backup package for other vehicles. The satellite will be designed for maximum spherical symmetry and should provide a measurement of the outer shell temperature and the internal package temperature of the satellite, which will be directly applicable to the design of the 20-inch satellite. In addition to the provision of a redundant system by the second transmitter, the possibility exists of a substantially increased lifetime of the second transmitter by the use of solar cells as its power source.

SCIENTIFIC EXPERIMENTS AND INSTRUMENTATION

The basis of the temperature measurements to be made by the new six-antenna minimum satellite is the accurate correlation between crystal temperature and operating frequency in such low-powered transistor oscillators.* One transmitter, including the battery pack of 7 RM-12 mercury cells will be mounted within the internal package, thereby providing a received frequency at the ground station that will provide the temperature of this package to ±5°C. A second transmitter will also be mounted within the internal package except for its frequency-controlling crystal, which will be mounted just beneath the outer shell, and a supply of six solar-cell patches which will be mounted symmetrically on the external shell. The output frequency of this second transmitter will provide a measure of the outer shell temperature to ±5°C. Both crystals will be selected for linear temperature-frequency characteristics within a range of about 100°C centered at the estimated operating temperature. The battery-powered transmitter in the internal package will operate at 108.00 Mc and its signal will be received by the regular ground Minitrack stations, while the solar-powered transmitter measuring the outer shell temperature will operate at 108.030 Mc and will be received by the ground Minitrack telemetry receiver. Both ground receiving systems will measure the actual received frequency, thus providing a temperature resolution of better than ±5°C.

The solar cell patches, mountings, and protecting shields are being designed and provided by the Signal Engineering Laboratories.

Six antennas will be used—four for the circularly polarized signal from the battery-powered transmitter and two for a dipole antenna to be used with the solar-powered transmitter. The Minitrack stations will be provided with crystals corresponding to this oscillator frequency so that tracking may be carried on after the original batteries have ceased to function. The dipole antenna pattern will also be used for ionospheric studies not possible with the circularly polarized pattern.

---

*P.V.R. No. 12, p. 14

THEORY AND ANALYSIS

Owing to the heavy weight of the instrumented nose cone carried with the TV-1 third stage, as compared with the weight of the satellite, unbalance in the nose cone has an undue effect on the flight path deviation. A six-degrees-of-freedom digital-computer study was initiated and completed on the NORC computer (Naval Proving Ground, Dahlgren, Va.) to determine the adequacy of the gyroscopic stabilization. The study indicated the necessity of spinning the nose cone in order to meet range safety requirements. This was accomplished by preloading the bearing connecting the nose cone and the third stage.

A general formulation of the problem of the Look Angle (azimuth and elevation of the rocket as viewed from a tracking station) was programmed for the Burroughs E102 computer. Look Angles for TV-1 were computed and sent to the field group.

Seven charts for the 200-1500 mile orbit at solar declinations 0, ±10, ±20, ±23.5 degrees showing sunlit percentage for apogee toward, away from, and 90 degrees from sun have been computed and sketched. All but two similar charts for the 200-800 mile orbit have also been completed.

Computations of the orientation of apogee have now been completed for solar declinations 0, ±10, ±20, ±23.5 degrees. Charts of the latter results have been mostly completed.

ELECTRONIC INSTRUMENTATION

TELEMETERING

PPM/AM Systems

A new titling mechanism has been developed to mark the film and/or paper ppm/am telemetry records as to (1) date of test, (2) test number, (3) station, and (4) rack number. If this unit proves successful, three more will be constructed.

The Wilkes Precision Instrument Company has delivered ten more video recorder film magazines, and has redelivered the five magazines which NRL returned for reworking;* three of the latter have again been returned to Wilkes.

Four more AN/DKT-7 vehicle transmitters and five spare rf transmitting heads have been delivered by the James Spivey Co.

PWM/FM Systems

A prototype of the newest pwm/fm transmitter package* has successfully withstood three-axis vibration tests at specification levels, and has been operated for 15 minutes in an oven at 71°C with satisfactory results. During the temperature test, the transistor heat sink reached 81°C, or 10° below the maximum allowable temperature. This transmitter package, which utilizes a transistorized power supply and omits a cooling fan, is 8 pounds and 100 cubic inches smaller than the original dynamotor-powered unit. The elimination of the filament dropping resistors by adding a filament winding to the power supply transformer has reduced the heat dissipation power loss of this transmitter by about 60 watts. Studies are underway to determine the reliability of the transistorized supply. Two standard dynamotor-powered transmitters are under construction as reserve units.

FM/FM Systems

The fm/fm transmitter package is being modified to employ a transistorized power supply, and the rf power amplifier is being reoriented for greater ease of tuning. The consequent weight reduction should be in the order of 3 pounds. However, this gain will be offset by a weight penalty of slightly over 1 pound resulting from the addition of an air fan and of a capacitor for increased filtering in the subcarrier B+ line.

The transistorized voltage regulator in the fm/fm package is being studied to determine the cause of some recent bench-test failures.

VEHICLE TRACKING

The required changes† in the first C-band AN/DPN-48 (XE-1) radar beacon have been completed at the Melpar plant, and the magnetron and plumbing required for completion of the second C-band beacon have been procured.

*P.V.R. No. 15, p. 16
†P.V.R. No. 15, p. 17

The environmental tests of the second S-band version of this beacon have been completed, but the inspection is still incomplete. It is expected that this unit will be delivered in the very near future.

Problems in the procurement of suitable equipment, particularly miniature C-band magnetrons, are still hampering plans for a gradual switchover from S-band to C-band beacons in the Vanguard program.

THE MINITRACK SYSTEM

The third session of the Minitrack Training Program was started on 15 March, with 12 Army enlisted men in attendance. The first class, consisting of 6 Army Captains and 6 enlisted men, completed this course on 5 April. The second class started on 1 April and will complete its session on 3 May. A need for additional sessions is anticipated to train the full complement of Army personnel, scientists from NRL, NEL, Latin American countries, and Australia, contractor engineers, and other interested groups who have requested attendance. A scientist will arrive from Australia on 27 May. An attempt will be made to reserve the fifth class beginning 27 May for NRL and NEL scientists and senior Army personnel.

The engineering model of the ground station electronics trailer was given a preliminary acceptance test on 3 April at the Bendix Radio Division of Bendix Aviation at Towson, Maryland; no serious defects were observed in any part of the system. Following this test, the trailer, complete with all components of the electronic rack assemblies which will not be packed individually, was given a 100-mile road test over first and second class roads to check the capability of the equipment to withstand shipping. The route was from Towson to Washington, where a stopover was made for inspection of the trailer by NRL personnel. Upon the return to Towson, a complete check of all components of the trailer by Bendix personnel indicated no defects or failures caused by this road test. As a result of recommendations made at NRL, the supports for the fold-away record analysis counters in this trailer were reworked to provide a secure wall bracing system. The final acceptance tests of this trailer by NRL and Inspector of Naval Materials personnel are planned for 18 April, and final delivery for 23 April. The delivery will thus be nearly 5 weeks ahead of the contract schedule of 20 May.

After delivery at NRL, this trailer will be set up at NRL for a period of about three weeks undergoing extensive system and drift tests on a 24-hour 7-day-week basis.

The NRL prototype Minitrack electronic trailer at the Blossom Point station has undergone approximately three weeks of continuous (24 hours per day, 7 days per week) operation. Internal electronics drift has not exceeded ±1 degree of phase at any time during the run; this drift corresponds to a space angle of ±12 seconds. During actual operations, a calibration immediately before and after a tracking event will reduce the drift error to about a third of a degree, corresponding to about ±4 seconds. No serious system failures occurred during this run, which included several primary power failures and low voltage intervals. Several aircraft calibrations were made during the test period, including one at the start of the run. A final aircraft calibration check will be made prior to the close of this run to permit measurements of long-time antenna-field and transmission-line drifts.

After this test the trailer, which has now been nine months at Blossom Point, will be returned to NRL for renovation, including repainting and retiling of the interior. It will then be delivered to Minitrack Station No. 10 at Beacon Field, San Diego, California for operation by NEL.

Beginning about 22 April, the existing rf transmission lines at Blossom Point will be replaced with Phelps Dodge Styroflex line, and the four fine antennas will be replaced with production antennas from the Technical Applicance Corporation (TACO).

Delivery of the production antennas is now beginning, with four units scheduled for delivery to NRL during the week of 15 April. Tests at the TACO plant indicate that the desired voltage standing-wave ratio of 1.05 is being obtained on nearly all units produced.

Two additional Mark II time standard units have been completed and are undergoing final tests.

The form of the message to be transmitted from each Minitrack station to the control center after a satellite passage has been established and will be published in the near future. In addition to the message form, conventions of direction and sign have been agreed upon.

The Vanguard control center is now under construction at NRL. This center will provide the central technical control point for the Minitrack network, and will include direct teletype links with all Minitrack stations, plus teletype links with the Vanguard computing facility, the Army Project Vanguard Task Force headquarters at the Army Map Service, the Smithsonian Astrophysical Observatory, the Army Signal Engineering Laboratory, and other contributing agencies. Completion of the center is scheduled for June 1957.

DATA PROCESSING

TELEMETERED DATA

Radiation, Inc. will deliver the digital data recording trailer of the automatic recording and reduction facility (ARRF) to the telemetry pad at CCMTA on 19 April 1957 in preparation for digital recording of only ppm/am data during the flight firing of TV-1.* This recording will be very useful in checking the performance of the reduction portion of the ARRF system. The interim system for playback of the data in nonlinearized form will be ready early in May. The pwm/fm and fm/fm portions of the data recording system should be completed late in May. The entire ARRF system is scheduled for completion about the end of July 1957.

ORBITAL DATA

Building modifications of the Vanguard Computing Center being established in Washington by IBM will be completed in May 1957. An IBM 704 computer will be installed in time for the center to be in operation sometime in June 1957.

IBM mathematicians have continued performing test calculations on the 704 computer and programming various subroutines for use in orbit determination and prediction.

THIRD-STAGE FIRING PREDICTION

The AN/FPS-16(XN-2) radar has been placed in operation at RCA, Moorestown; tracking of aircraft and of balloon-borne metal spheres indicates excellent performance. The XN-2 will be ready for air shipment to Grand Bahama Island (GBI) on 20 May. The wiring modifications of the AN/FPS-16(XN-1) radar are now being checked out; this radar is still expected to be ready for shipment on 31 May. Because of the shortage of large transportation aircraft, it is now planned to ship the XN-1 system to PAFB by truck rather than by air. The building for the XN-2 on GBI should be completed for beneficial occupancy on 30 April 1957.

Experimental use of the digital impact prediction system (XN-1 radar at PAFB, digital data transmission system, and IBM 704 computer at Cape Canaveral) is still planned for the firing of TV-2.

---

*P.V.R. No. 15, p. 20

RANGE OPERATIONS

The instrumented nose cone for TV-1 arrived at AFMTC on 18 March. The receiving inspection, transducer calibration, and checks of Dovap, radar beacon, and telemetry installations were completed. A trial assembly of the first-stage transition section, inert third-stage bottle, and instrumented cone has been conducted satisfactorily. The first stage (Viking 14) has been erected on the launch stand and preparations for a static firing on 18 April are well underway. The launching of TV-1 is now scheduled for 29 April.

As a result of recent revisions in the Martin Company's schedule of vehicle deliveries, it has been necessary to revise the schedule of firings at AFMTC. The new schedule, starting with TV-2, is given below:

Vehicle	Firing Date
Test Vehicle No. 2	26 July 1957
Test Vehicle No. 2 Back-Up	6 Sept 1957
Test Vehicle No. 3	15 Oct 1957
Test Vehicle No. 3 Back-Up	22 Nov 1958*
Test Vehicle No. 4	16 Dec 1957
Test Vehicle No. 4 Back-Up	17 Oct 1958*
Test Vehicle No. 5	14 Feb 1958
Satellite Launch Vehicle No. 1	21 March 1958
Satellite Launch Vehicle No. 2	25 April 1958
Satellite Launch Vehicle No. 3	30 May 1958
Satellite Launch Vehicle No. 4	3 July 1958
Satellite Launch Vehicle No. 5	8 Aug 1958
Satellite Launch Vehicle No. 6	12 Sept 1958

*These firing dates for TV-3 BU and TV-4 BU apply if the vehicles are not used during the test vehicle phase. They will be delivered and available for use as back-up vehicles for TV-3 and TV-4, if required.

CONFIDENTIAL

Naval Research Laboratory. Report 4950 (CONF.) PROJECT VANGUARD REPORT NO. 16 - PROGRESS THROUGH APRIL 15, 1957 (Unclassified Title), by Project Vanguard Staff, 15 pp. May 1, 1957.

This report is intended as a general summary of the progress on Project Vanguard during the indicated period. Hence, minor phases of the work are not discussed to a great extent, and technical detail is kept at a minimum. It is hoped that the information here presented will be of assistance to administrative and liaison personnel in coordinating and planning their activities, and as a guide to the current status of the project. Material of a more technical nature will be published from time to time in separate reports which will be announced in subsequent monthly progress reports.

CONFIDENTIAL

1. Satellite vehicles - Launching
2. Satellite vehicles - Research
3. Rockets - Development

I. Project Vanguard

CONFIDENTIAL

Naval Research Laboratory. Report 4950 (CONF.) PROJECT VANGUARD REPORT NO. 16 - PROGRESS THROUGH APRIL 15, 1957 (Unclassified Title), by Project Vanguard Staff, 15 pp. May 1, 1957.

This report is intended as a general summary of the progress on Project Vanguard during the indicated period. Hence, minor phases of the work are not discussed to a great extent, and technical detail is kept at a minimum. It is hoped that the information here presented will be of assistance to administrative and liaison personnel in coordinating and planning their activities, and as a guide to the current status of the project. Material of a more technical nature will be published from time to time in separate reports which will be announced in subsequent monthly progress reports.

CONFIDENTIAL

1. Satellite vehicles - Launching
2. Satellite vehicles - Research
3. Rockets - Development

I. Project Vanguard

CONFIDENTIAL

Naval Research Laboratory. Report 4950 (CONF.) PROJECT VANGUARD REPORT NO. 16 - PROGRESS THROUGH APRIL 15, 1957 (Unclassified Title), by Project Vanguard Staff, 15 pp. May 1, 1957.

This report is intended as a general summary of the progress on Project Vanguard during the indicated period. Hence, minor phases of the work are not discussed to a great extent, and technical detail is kept at a minimum. It is hoped that the information here presented will be of assistance to administrative and liaison personnel in coordinating and planning their activities, and as a guide to the current status of the project. Material of a more technical nature will be published from time to time in separate reports which will be announced in subsequent monthly progress reports.

CONFIDENTIAL

1. Satellite vehicles - Launching
2. Satellite vehicles - Research
3. Rockets - Development

I. Project Vanguard

DISTRIBUTION

	Copy No
DEPARTMENT OF DEFENSE (21 Copies)	
Asst. Secretary of Defense (R&D)	1-10
Asst. Secretary of Defense (R&D) Attn: J. C. Myers	11-20
Asst. Secretary of Defense (Compt.) Attn: Prog. Reports & Statistics Division	21
NAVY DEPARTMENT (50 Copies)	
Asst Secretary of Navy (Air)	22
CNO Attn: Code Op-51 (2)	23-24
Code Op-05 (1)	25
Navy Comptroller	26
ONR (10)	27-36
NOTS, China Lake, Calif	37
NAMTC, Pt Mugu, Port. Hueneme, California	38
BuOrd Attn: Code ReSl	39
Code Sp	40
BuAer Attn: GM-12	41
BuY&D Attn: CDR L P Frate	42
Western Development Div, Air Research & Dev. Com., 401 E Manchester Blvd, Inglewood 45, Calif. Attn: Navy Liaison Officer	43
BuShips	44-45
CHINFO (Vanguard Project Officer) EXOS	46
SenNavOfficer, Navy Office ABMA, Redstone Arsenal	47
CO, USNOTU, AFMTC, PAFB, Fla. Attn: (Vanguard Project Office – MTQXV)	48-67
USNEL, San Diego, Calif Attn: Code 2220	68
Naval Observatory, Washington, D. C.	69
CDR, USNOL, White Oak, Silver Spring, Md Attn: E. Liberman, Libr.	70
Naval War College, Newport, R. I	71
DEPARTMENT OF THE ARMY (42 Copies)	
Asst Secretary of the Army (R&D)	72
Asst Secretary of the Army (Log.)	73
Office of Chief of Staff (Army) Attn: DCS Log (Plans & Progs.)	74
Office of Chief of Staff (Army) Attn: Chief R&D (9) CS Mil Ops (1)	75-84
Office of Chief of Ordnance Attn: ORDTB (1)	85
ORDTU (1)	86
Office of Chief Signal Officer Attn: SIGAC (3) SIGRD (1)	87-90
Office of Chief of Engrs. Attn: EID (ENGTI)	91
Signal Corps. Engineering Lab. Attn: Dir. of Research (2) Technical Libr. (1) Dir. of Engr. (2)	92-96
Army Map Service Attn: CO (1) Mr J. O'Keefe (1) Project Vanguard Task Force (1)	97-99
Ballistic Research Lab., Aberdeen, Md.	100
Diamond Ordnance Fuse Lab., Wash. D. C Attn: Library, Rm. 211, Bldg. 92	101
CDR, White Sands Proving Ground, New Mexico Attn: ORD Mission (1) ORDBS-OM-TIO-TL-464 (3) ORDBS-OM-TIO-TL-550 (2)	102-107
Redstone Arsenal, Huntsville, Ala. Attn: R&D (1) Tech Libr. (1)	108-109
ABMA, Redstone Arsenal (3)	110-112
Los Angeles Ordnance Dist., 55 So. Grand Ave., Pasadena, Calif. Attn: ORDEV-00	113
DEPARTMENT OF THE AIR FORCE (21 Copies)	
Asst. Secretary of Air Force (R&D)	114
Deputy Chief of Staff, Development, U.S. Air Force	115-117
Asst Chief of Staff, USAF Attn: Guided Missiles	118
Directorate of Dev Planning, USAF Attn: (AFDAP) (2)	119-120
WADC, Wright-Patterson AFB, Dayton, Ohio Attn: WCOSI-3 (5)	121-125
ARDC, Baltimore, Md	126-128
AFCRC, ARDC, Bedford, Mass Attn: CRRT	129
CROOTR	130
Western Dev. Div., Air Research & Dev. Command, 401 E. Manchester Blvd., Inglewood 45, Calif Attn: Cdr. R. C. Truax	131-132
Air Research & Dev Comm, Griffis AFB, Rome, N. Y. Attn. RCENW	133
Dir, Air University Library, Maxwell AFB, Ala. Attn: AUL-7621	134
OTHERS (13 Copies)	
NSF (2)	135-136
Glenn L. Martin Co., Baltimore, Md (5)	137-141
General Electric Co., (Wash Office) Wyatt Bldg, Wash, D. C. Attn: J H. Bernhart	142
Aerojet-General Corp, Azusa, Calif	143
International Business Machine Corp, 1111 Conn. Ave., N. W., Wash 6, D C Attn: Mgr., Navy Accounts (2)	144-145
MIT Lincoln Lab, P.O. Box 73, Lexington 73, Mass. Attn: Miss M. A. Granese, Libr.	146
Univ. of Calif., Radiation Lab., Information Div., P. O. Box 808, Livermore, Calif. Attn: Mr. Cloves G. Craig	147
NRL (Internal Distribution 71 Copies)	148-218

FR 4748 - AD0343044
4767 - AD0 341439
4728 - AD0 342793
4717 - not in DTIC
4800 - AD0342755
4815 - AD0342991
4860 - AD0342505
4880 - AD0343187
4890 - AD0 343093
4900 - AD0342883
4910 - AD0343031
4930 - AD0342912
4950 - AD0342843
4995 - AD0139582
5010 - AD0342966
5020 - AD0 342882
5035 - AD0142782
5050 - AD0343170

Naval Research Laboratory
Research Reports Library
Code 5596.3

Date: 13 Dec 07

From: Judi Griffin code 5596.3

To: code 8100

CC: Vicki Cicala code 1226.3

Subj: Review of VANGUARD Progress reports for distribution change

Please Review: **FR-4717, FR-4728, FR-4748, FR-4767, FR-4800, FR-4815, FR-4832, FR-4860, FR-4880, FR-4890, FR-4900, FR-4910, FR-4930, FR-4950, FR-4995, FR-5010, FR-5020, FR-5035, FR-5050, FR-5113, FR-5185, FR-5217, FR-5227**

For possible Distribution Statement Change to: APPROVED FOR PUBLIC RELEASE – DISTRIBUTION UNLIMITED

5113 - AD0343179
5185 - AD0203077
5217 - AD0204045
5227 - AD0206096
4832 - AD0343162

Thank You
Judi Griffin
(202) 767-3425
Judi.griffin@nrl.nvy.mil

The Subject Report(s) can be (please sign after appropriate change):

Changed to Distribution A (Unlimited) P.G. Wilhelm

Changed to Classification ____________________

Other: ____________________